PART C: ATTAINMENT DEMONSTRATION

9.0 MODELING

The federal CAAA require complex photochemical modeling for all serious and above nonattainment areas to demonstrate that the areas will attain ozone standards by the mandated deadlines. Photochemical ozone models are mathematical representations of the changes that occur when air pollutants are emitted into the atmosphere, travel downwind and, in the presence of sunlight, react photochemically to form ozone.

The regulatory application of modeling affects a broad spectrum of society. The geographical area included in the model encompasses multiple geopolitical boundaries (counties, local governments, states) with a potentially large regulated community. Therefore, application of photochemical modeling requires coordinating a large number of technical and policy decisions in order to operate, interpret and use the model consistently.

9.1 HOW MODELS OPERATE

Two photochemical models are used which affect the Philadelphia nonattainment area. They differ technically primarily in the geographical area covered.

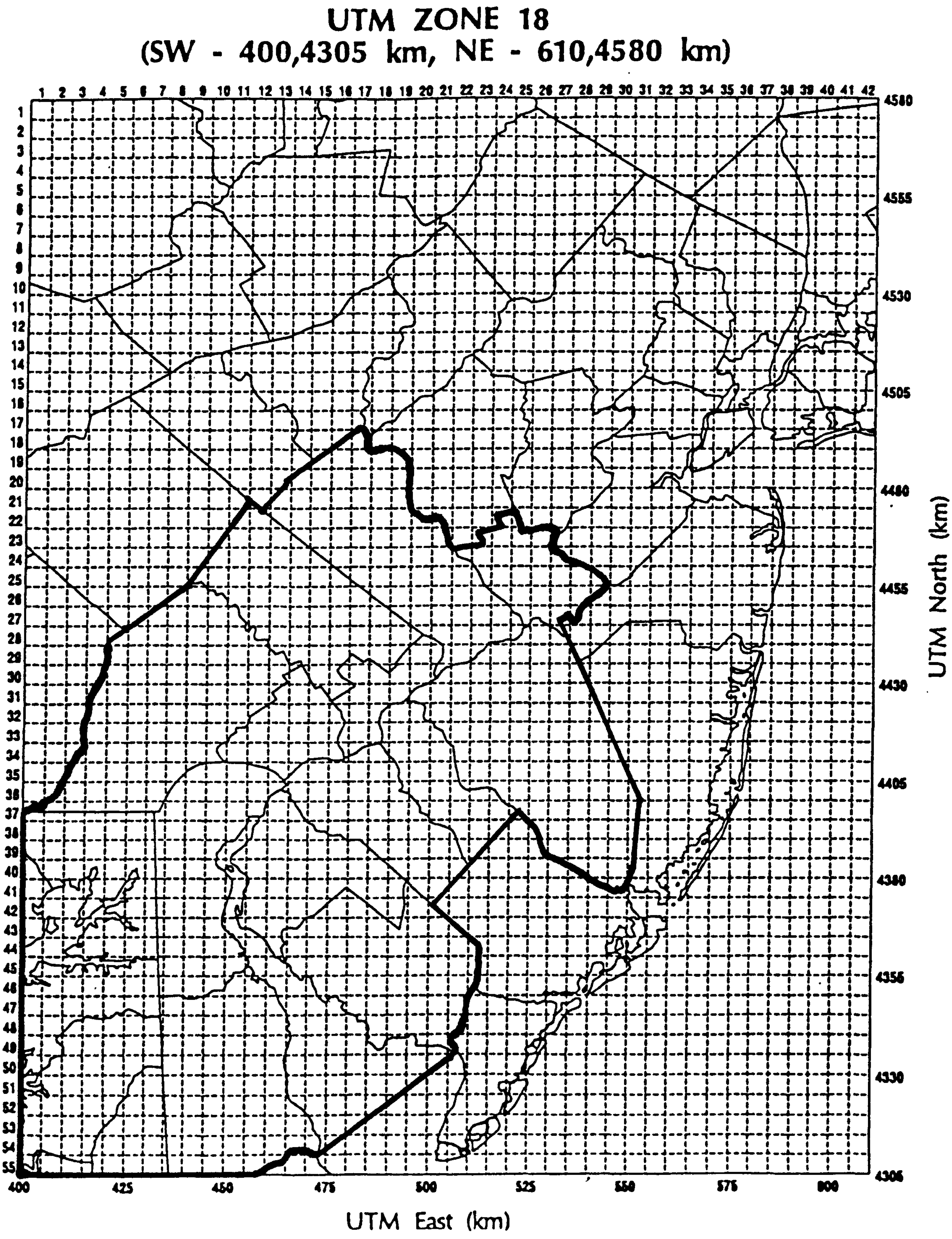
The photochemical model currently approved by EPA for attainment area demonstrations is the fourth generation of the Urban Airshed Model (UAM IV). Other models are under development but are not as yet approved by EPA for this purpose.

The model currently approved by EPA for regional attainment assessment, which also provides input into the UAM model, is the Regional Oxidant Model 2.2 (ROM). This modeling is being completed for the Northeast states by EPA and by a state/EPA/industrial cooperative called Modeling Ozone Cooperative Association (MOCA).

9.1.1 URBAN AIRSHED MODELING (UAM)

The Urban Airshed Model is essentially a large number of square columns in which air pollutants are emitted, mixed, chemically reacted and then passed on to the surrounding squares. Figure 9.1 shows how the interstate Philadelphia area has been divided for this modeling effort, with the actual nonattainment area heavily outlined. Each square indicated by the grid is 5 kilometers wide by 5 kilometers long. The entire area is called the modeling domain.

Figure 9.1: Philadelphia Modeling Domain



The size of the entire modeling domain is determined in part by the geographic area necessary to model the full extent of the Philadelphia ozone plume.

The model incorporates altitude as well to accurately predict the chemical reactions in the atmosphere. The height of the column thus varies depending on daily meteorological conditions. The model calculates where, due to wind flow, the chemical mixing takes place in the atmosphere. Schematically, each column is divided vertically into five layers, with the top layer always above the mixing height. Greater detail is available in EPA's UAM IV guideline documents.

Several types of input are necessary to use the model:

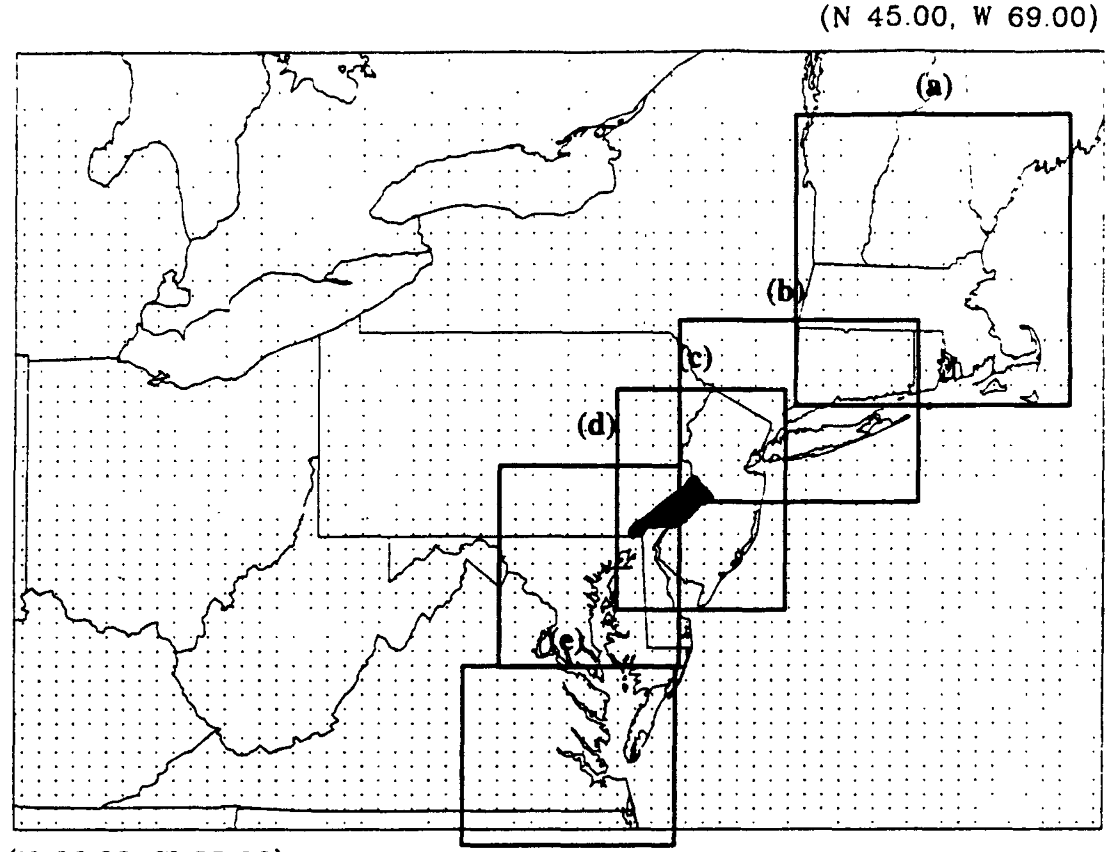
- Emissions and their location must be known. These data are supplied by the individual states in their emission inventories.
- Meteorological conditions such as wind speed, wind direction, cloud cover, solar radiation and temperature are supplied from a variety of sources, primarily National Weather Service stations.
- Boundary conditions must be known. Boundary conditions are expressed as a concentration of ozone and ozone precursors on the edges of the modeling domain. This is particularly important in the Northeast where quite often, the air coming into the domain during the modeled episodes will already violate air quality standards. The expected future amounts of pollution on the boundaries must be established in order to predict pollution levels in the attainment year, 2005. Currently, the accepted method for obtaining this data is from EPA's Regional Oxidant Model 2.2 (ROM). EPA has run the regional model for the entire eastern United States for a series of historical episodes. This data is obtained from EPA and used for boundary conditions throughout the UAM modeling.

9.1.2 ROMNET

Figure 9.2 shows the Northeast portion of the area where the ROM model has been run. The term ROMNET refers to the application of the ROM model in the Northeast. The dots on the figure define the grid for ROM.

Figure 9.2: ROMNET

UAM DOMAINS NESTED WITHIN GRIDDED ROMNET REGION



(a): New England UAM Airshed
SW corner (120 km E, 4570 km N) Zone 19, 68x68 cells

(b): New York UAM Airshed
SW corner (480 km E, 4440 km N) Zone 18, 58x46 cells

(c): NJ-Philadelphia UAM Airshed
SW corner (400 km E, 4305 km N) Zone 18, 42x55 cells
PA portion of nonattainment area shown as solid

(d): Baltimore-Washington UAM Airshed
SW corner (250 km E, 4235 km N) Zone 18, 46x50 cells

(e): Virginia UAM Airshed
SW corner (734.876 km E, 4002.832 km N) Zone 17, 53x49 cells

The ROM model operates like the UAM model except the size of the grids is larger, approximately 20 x 20 km. The figure also shows the UAM modeling domains for the five east coast areas where UAM attainment modeling is ongoing.

As discussed in the section on UAM modeling above, the size of each domain was established to encompass an entire urban ozone plume. The interlocking domains, with the Philadelphia domain at its heart, indicate graphically the complex and interdependent nature of regional ozone problems and solutions.

9.2 URBAN NONATTAINMENT MODELING REQUIREMENTS

By operation of law, the CAAA designated Philadelphia as an interstate ozone nonattainment area and classified it as severe. Figure 9.3 shows this interstate nonattainment area. Therefore, photochemical modeling must be used to demonstrate that the interstate Philadelphia area will attain the federal health-related ozone air quality standard by November 15, 2005.

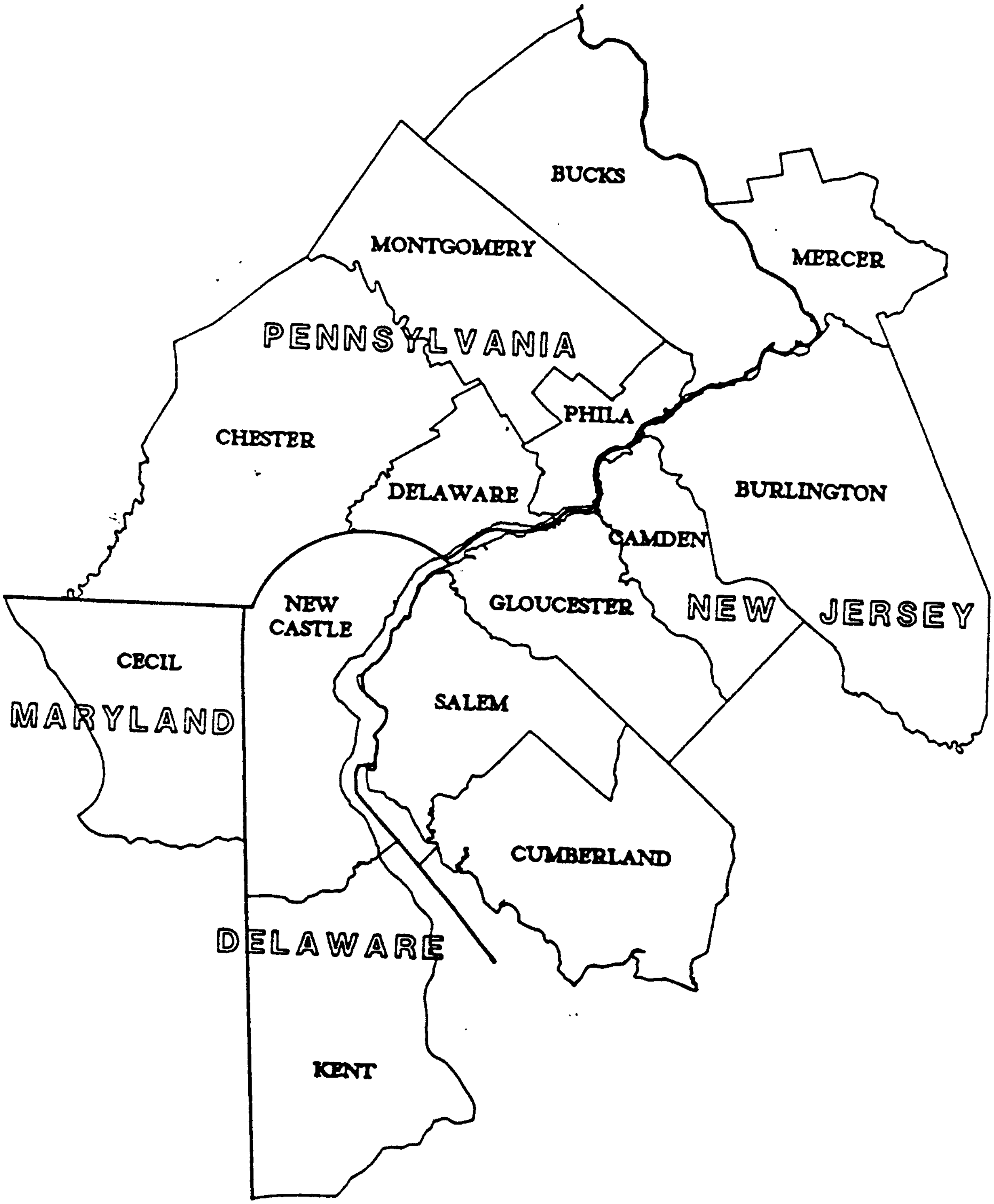


Figure 9.3: The Philadelphia Interstate Ozone Nonattainment Area

A simple overview of the modeling process includes:

- The model is tested to demonstrate that it is a valid tool for prediction. This is done by testing whether the model can accurately predict ozone values for historical ozone episodes (where the actual measured ozone concentrations are already known). The model is run for several different episodes and refined until it can make these predictions.
- The model is then used to predict future ozone levels, based on expected changes in emissions, assuming the same meteorological conditions re-occur. These simulations are run for the same meteorological episodes as the validation.
- If decreases in emissions already accounted for above do not result in the attainment of the ozone standard, the model is run with additional emission reductions until the model predicts the standard will be attained. States must adopt and enforce control measures which achieve the additional emission reductions that the model indicates are needed.

9.3 STEPS FOR CONDUCTING A UAM STUDY

The following section describes the steps which have been followed for the conduct of the Philadelphia nonattainment area UAM modeling study[14] and describes the progress made to date.

9.3.1 ESTABLISHMENT OF A DETAILED TECHNICAL PROTOCOL

Because of the complexities and potential impact on the regulated community, it was critical early on to establish a detailed technical protocol for the modeling study. The adopted modeling protocol for the Philadelphia nonattainment area is titled "Protocol for Regulatory Photochemical Air Quality Modeling of the Metropolitan Philadelphia - Southern Central New Jersey Area." This document is available on request. The Protocol details and formalizes procedures for conducting the modeling study including:

- Stating the background, objectives, tentative schedule and organizational structure of the study,
- Developing the necessary input data bases,
- Conducting quality assurance and diagnostic model analyses,
- Conducting model performance evaluations and interpreting modeling results, and
- Describing procedures for using the model to demonstrate whether proposed strategies are sufficient to attain the ozone National Ambient Air Quality Stndard (NAAQS).

A. Sponsoring and Participating Organizations

The computational implementation of the Metropolitan Philadelphia photochemical modeling study is being performed by the Ozone Research Center (ORC) at the Environmental and Occupational Health Sciences Institute (EOHSI[15]). The organizations which are sponsoring the modeling study are:

Pennsylvania Department of Environmental Resources
Philadelphia Department of Public Health--Environmental Protection Division
Delaware Department of Natural Resources and Environmental Control
Maryland Department of the Environment
New Jersey Department of Environmental Protection and Energy (NJDEPE)
EPA Office of Air Quality Planning and Standards
EPA Region II (New York)
EPA Region III (Philadelphia)

In addition to the above listed agencies the following organizations are also contributing to the modeling effort (a) by providing emission and aerometric data and recommending and evaluating control strategies, (b) by comparing and discussing concurrent modeling efforts in the Northeastern US, and (c) by providing additional technical resources:

New York State Department of Environmental Conservation
EOHSI
NorthEast States Coordinated Air Use Management/Mid-Atlantic Regional Air Management Association
OTC
Delaware Valley Regional Planning Commission

B. Management Structure: Committees and Technical Working Groups

The need to coordinate activities involving policy and technical decisions at nine federal and state agencies requires a flexible management structure. The modeling project is administered by a Policy Oversight Committee and a Technical Coordination and Strategy Development Committee which work closely with three Technical Working Groups. Input and evaluation of databases for the photochemical airshed simulations are developed by the Emissions Technical Working Group and the Aerometric Data Technical Working Group; computational implementation and scientific analysis of the modeling project is performed by the Air Quality Modeling Group of the Ozone Research Center at the Environmental and Occupational Health Sciences Institute (EOSHI). Each Committee and Technical Working Group is chaired by a Coordinator who is responsible for establishing regular interaction among Committee/Group members and for following and reporting the progress of tasks undertaken by the Committee/Group. A representative from each sponsoring organization/agency participates in each Committee or Group. The responsibilities of each participant, and therefore of the corresponding agency, are specified by the respective Committee/Group. Members of the Technical Coordination and Strategy Development Committee directly report to and interact with the corresponding members in the Policy Oversight Committee from their agency/organization. Furthermore, since the Technical Coordination and Strategy Development Committee has the lead in specifying modeling procedures and in identifying data needs, its members are responsible for coordinating/tracking Technical Working Group activities locally, i.e. within their agency/organization.

The organizational structure and the responsibilities of these groups are outlined in the following sections.

The Policy Oversight Committee

Responsibilities of the Policy Oversight Committee are to:

Set the objectives of the study,
Approve the project plan and time schedule,
Determine resource needs and assure that required resources become available on time,
Allocate responsibilities to project participants,
Approve and guide implementation of needed modifications to the modeling protocol as the modeling study proceeds,
Direct the preparation of needed databases (emissions, air quality) and assure that participating state agencies provide the necessary information on time,
Provide (in collaboration with the technical coordination and strategy development committee) projections for future base case emissions consistent with ROMNET, OTC and CAAA;
Provide policy on emission reductions consistent with ROMNET and OTC,
Resolve issues on which the technical coordination and strategy development committee cannot reach an agreement,
Review and approve the modeling protocol and the final modeling results (following approval by the technical coordination and strategy development committee).

The Technical Coordination and Strategy Development Committee

Responsibilities of the Technical Coordination and Strategy Development Committee are to:

Review and approve the technical specifications for the Modeling Protocol,
Oversee and review the implementation of the modeling project in relation to the specifications listed in the Modeling Protocol,
Select the episodes to be simulated and the attributes of the modeling domain,
Develop and justify modifications to the Modeling Protocol as needed during the implementation of the modeling project,
Develop (in collaboration with the policy oversight group) emission scenarios for the base case, future base case and control strategies,
Review and approve results of model performance and of control strategy simulations, that will be provided by the air quality modeling group,
Guide and approve modifications/refinements of model inputs to improve model performance,
If deemed necessary, develop and justify alternative procedures for attainment demonstration,
Demonstrate attainment/nonattainment as required by EPA Guidelines.

The Emissions Technical Working Group
The Emissions Technical Working Group is responsible for providing the emissions data necessary for running the base case and control strategy simulations. The Emissions Technical Working Group is staffed with technical personnel from each participating state agency that has the responsibility to provide necessary data, projections and information on standard data-handling agency practices to the Air Quality Modeling Group. The Emissions Technical Working Group is headed by a Group Coordinator.

The Aerometric Data Technical Working Group
The Aerometric Data Technical Working Group is responsible for providing the aerometric (air quality and meteorological) data necessary for evaluating model performance and for running various diagnostic tests. The Aerometric Data Technical Working Group is staffed with technical personnel from each participating state agency that has the responsibility to provide necessary data and information on standard data-handling agency practices to the Air Quality Modeling Group. The Aerometric Data Technical Working Group is headed by a Group Coordinator.

The Air Quality Modeling Group
Responsibilities of the Air Quality Modeling Group are to:

Advise the Policy Oversight Committee and Technical Coordination and Strategy Development Committee with regard to the scientific validity and relevance of the modeling methods used in the State Implementation Plan,
Identify the technical background for the Regulatory Photochemical Modeling Protocol,
Identify resource and data needs for the modeling project, that will have to be addressed by the participating agencies,
Identify working modeling domains and appropriate base case episodes,
Organize and quality-assure the emissions and aerometric databases that will be available through the participating State Agencies,
Perform UAM simulations for historic data and for present and future base cases (including diagnostic analyses and diagnostic/operational model performance evaluations),
Identify and specify the ROM simulations required for the various phases of the project,
Collaborate with EPA OAQPS personnel to coordinate the assessment of urban-regional interactions,
Review, analyze (and present in reports) results of model performance,
Perform control strategy simulations and present the results of these simulations to the policy and technical groups.

The Ozone Research Center

The Ozone Research Center at EOSHI has the responsibility for providing the scientific analysis of the ozone nonattainment problem and for actually implementing the air quality modeling part of the project through computer simulations and detailed diagnostic analyses and evaluations.

9.3.2 IDENTIFICATION OF MODELING BOUNDARIES

The appropriate boundaries of the domain to be modeled and the methods used to determine initial and boundary conditions for air quality and meteorology information were determined. The boundaries of the domain were determined as a compromise between the computational demands for enlargement of the domain and an acceptable level of error. Factors which were considered to optimize the boundary selection included a) the degree of correlation among ozone monitoring stations as a function of distance, b) the simulation of forward and backward air-mass trajectories from selected locations (source and receptors) in the domain, and c) the performance of simulations over domains of decreasing size to determine the importance of domain size effects.

9.3.3 DETERMINATION OF ALTERNATIVE METHODS TO CALCULATE EMISSION AND METEOROLOGICAL INFORMATION

Alternative methods were identified for managing and calculating detailed, episode-specific emission and meteorological information. A preliminary evaluation of "pre-processor" models and methods for managing data was completed to select the most efficient method of inputting and managing data bases for the model.

9.3.4 SELECTION OF BASE-CASE HISTORICAL OZONE EPISODES

Specific historical episodes need to be selected during the period from 1987 to the present which are representative of the different meteorological regimes conducive to ozone formation in the modeling domain. While theoretically, modeling simulations should be performed for every ozone episode for an entire three-year period, such an option is not viable due to limitations in data, resources and time. Therefore, the approach taken was to simulate a limited number of high ozone days. Episodes selected corresponded to high ozone observations but not always the highest observations. The episode selection process recommended by EPA is based on identifying meteorological regimes by constructing a "climatological windrose" of high ozone days. This process consists of the following steps:

A . Establish days with ozone levels greater than the NAAQS.

B . Determine the 7 to 10 AM resultant wind vector for all days chosen in step (a), and allocate them into eight compass directions and calms.

C . Establish the Predominant Wind Directions (PWD), based upon the maximum counts in one of the eight compass directions or calms.

D . Assign each episode day based upon its resultant wind vector to the PWD or other category and rank-order them based upon the observed ozone concentrations.

In practice, the above procedure may be appropriate for isolated urban domains having a single representative meteorological station, rather than for extended urban areas with complex topography (e.g., involving coastlines or valleys etc.) or involving regional transport. For such areas the PWDs may be significantly different from meteorological station to station and lumping different stations together may not be appropriate. An alternvative approach that ha been adopted in SIP modeling domains of the Ozone Transport Region (OTR) is to consider synoptic scale wind patterns to identify regimes associated with high ozone occurrences. In the New Jersey - Philadelphia domain ozone episodes from 1987 to 1991 were classified in five synoptic meteorological regimes corresponding to:

1. prevailing S/SW winds (the majority of episodes),
2. high pressure system above the domain - no significant transport (very few episodes),
3. high pressure N or W of the domain (few episodes),
4. frontal boundary within the domain (some episodes), and
5. other, more complicated, meteorological conditions (some episodes).

After the meteorological regimes were determined, episodes were "ranked" according to various criteria such as observed ozone maximum, minimum and average values within the domain, duration of the episode, spatial extent ("pervasiveness") of the episode (according to the fraction of ozone monitors within the domain in exceedance of the standard), etc. Then episode days were selected from among the three highest-ranked episode days from each meteorological regime. According to EPA Guidance, the "primary" modeling day for the attainment demonstration, for each meteorological regime, may be chosen to include any of the three top-ranked days in that regime. In addition to considering the magnitude of the highest observed daily maximum ozone concentration in making this choice, data availability and quality, model performance, availability of regional modeling analyses, pervasiveness, frequency with which observed meteorological conditions coincide with exceedances, etc., are also recommended for consideration.

It should be mentioned the determination of the exact boundaries of the modeling domain and selection of the "primary" modeling days are not truly independent processes. It had to be confirmed that the domain's downwind boundaries were sufficiently far from the CMSA that is the principal focus of the modeling study. This was done to ensure that emissions from the CMSA occurring on the primary day for each selected episode remained within the domain until 8:00 p.m. on that day. The extent of the upwind boundaries also depends on the proximity of large upwind source areas and the adequacy of techniques used to characterize incoming precursor concentrations. Large upwind emission source areas were included in the modeling domain to the extent practicable.

After following the procedure outlined above, the following episodes were selected for evaluation:

Episode Modeling Dates	**Meteorological Regime**
July 5 - 11, 1988	Prevailing S/SW winds
June 14 - 15, 1987	High pressure North/West of domains
July 16 - 20, 1991	Prevailing S/SW winds

9.3.5 DATA AQUISITION

The modeling study requires acquisition and pre-processing (quality assurance, adjustment to day- and hour-specific temperature and activity, allocation to the appropriate grid cell, etc.) of air quality, meteorological and emissions data to develop the necessary information for each episode to be used in the attainment demonstration model simulations.

All of the air quality and meteorological data for all episodes has been collected and processed for use in the modeling study. Emissions data for the 1990 baseline and adjustment of that data as required to simulate daily emissions during the historical episodes has been collected from state and local air agencies. Processing of that data has also been completed.

9.3.6 MODELING SYSTEM EVALUATION

Once the various data bases are exercised in the model, it is necessary to assure that the pre-processors, and other modeling systems, are functioning properly and are producing reasonable results. This generally includes the following functions which have been completed:

- Application and component evaluation of major preprocessors (eg. wind-field generators, emission models, etc.) for each selected episode, using available field data.
- Application and evaluation of the complete modeling system with inputs prepared using meteorological and emission pre-processors for each selected episode.
- Implementation of diagnostic analyses on each meteorological episode simulation. The principal purpose of diagnostic analyses is to ensure that the model properly characterizes physical and chemical phenomena (e.g., wind fields, spatial and temporal emission patterns) instrumental in leading to observed ozone concentrations. The objective is to improve model performance, i.e., to achieve better spatial and temporal agreement with observed data. Diagnostic model simulations also uncover potential model input data gaps.
- Refinement and correction of inputs and input estimation methods, guided by the diagnostic analyses discussed above, followed by the "base case" application of the photochemical modeling system for each selected meteorological episode.

9.3.7 ANALYSIS OF MODELING RESULTS

The model must be analyzed using a series of graphical and numerical performance measures to determine overall model performance in replicating observed ozone concentrations and patterns including ozone precursors. This analysis is ongoing. However, preliminary results show the model performance at or above the protocol and EPA standards.

9.3.8 ESTIMATE EMISSIONS FOR PROJECTED ATTAINMENT YEAR

For each meteorological episode selected, emissions for the projected attainment year, 2005, must be estimated. Model simulations must be performed for each episode, implementing a) projections of future changes in emissions and b) mandated control measures included in the CAAA to determine whether the ozone standard will be met in 2005. Because the state inventories are not available modeling is proceeding using the federally developed 2005 interim emissions inventory to assess expected attainment status. Results are expected by January of 1995 and will be made available to the public. This modeling will be re-done using the state inventories which are expected to be completed in January 1995.

9.3.9 FINAL ATTAINMENT MODELING

If the model simulations for the attainment year do not show attainment for each modeled episode, additional emission control strategies for ozone precursors must be developed and the emission reductions for these strategies quantified. Model simulations incorporating these specific measures and/or a package of measures are performed to demonstrate attainment of the standard for each episode. If the control measures modeled do not show attainment, these steps are repeated as an iterative process until attainment is shown for each modeled episode.

9.4 INTERDOMAIN TRANSPORT

In cases where there is significant interdomain transport such as the Northeast corridor, regional and urban scale models are used in combination for the SIP modeling process. ROM must also be applied in the final steps of the above process, incorporating the control measures identified in the urban scale applications in order to study potential regional impact and interactions. Close and continuous collaboration among the modeling projects of adjacent domains are essential to the timely resolution of potential inconsistencies in both modeling approaches and policy recommendations.

9.5 PRELIMINARY RESULTS

A workshop on modeling and modeling results is planned for the future once additional results are available. However, ROM modeling for the Northeast for 2005 using an emissions inventory assuming the implementation of all CAAA mandatory measures shows the Philadelphia region remains in nonattainment. Results are shown in Figure 9.4. Peak concentrations exceed 160 parts per billion (ppb) compared to the standard of 120 ppb.

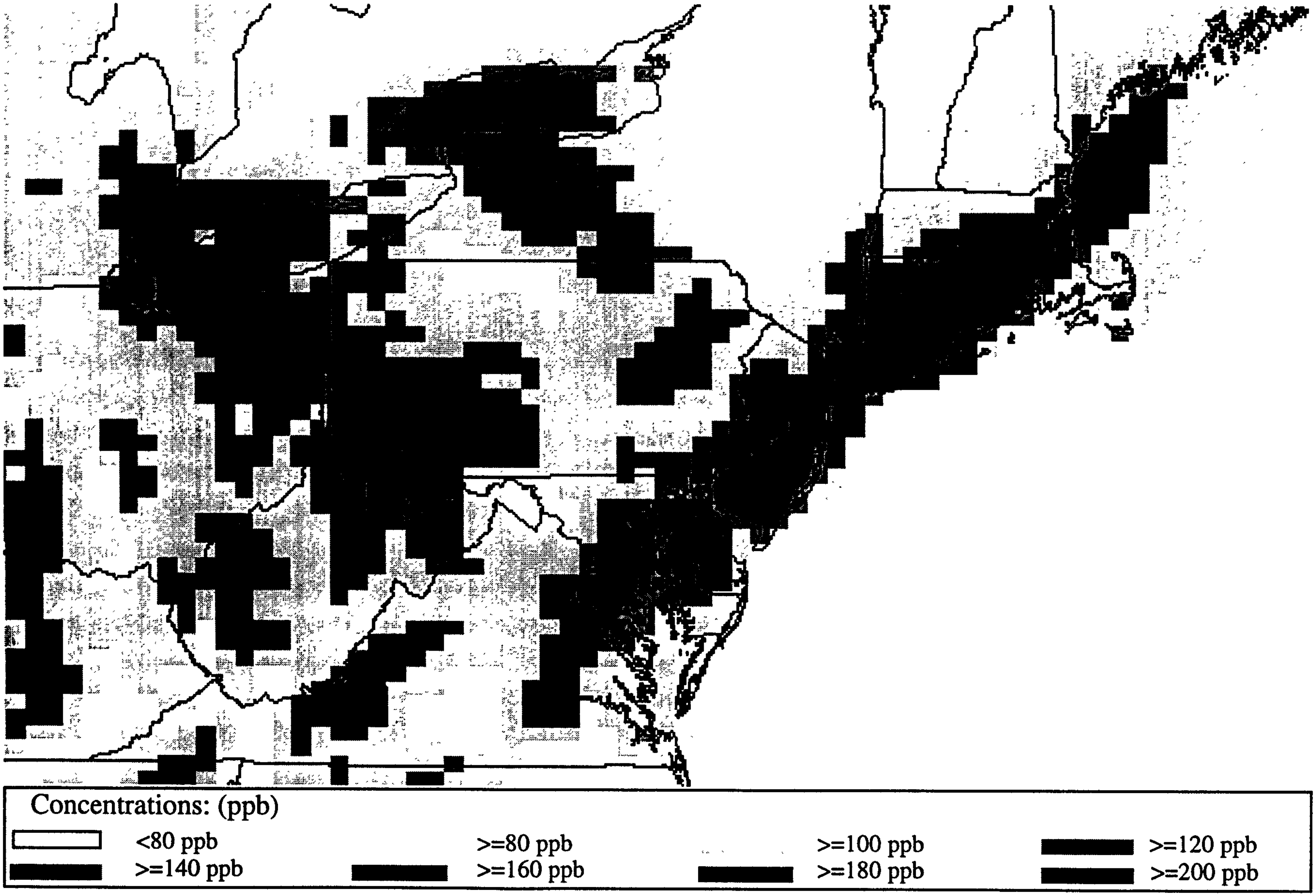


Figure 9.4 2005 Ozone Concentrations. (after mandated reductions.)

10.0 REQUIREMENTS FOR FURTHER CONTROL MEASURES

The CAAA of 1990 established a Northeast Ozone Transport Region and Ozone Transport Commission (OTC). The region was defined to include eleven Northeastern states from Maryland through Maine, the District of Columbia and portions of northern Virginia (Washington, DC suburbs).

The CAAA also made some specific control measures mandatory in areas by virtue of a state's inclusion in the region. For example, vehicle inspection/maintenance is required in more areas in an OTC state than in a state which is not part of the transport region. Finally, the law requires states to adopt any necessary emission controls beyond those required for local attainment in order to ensure the entire region meets air quality standards. The OTC was charged with working cooperatively to define those controls.

These regional attainment requirements have implications for the type and magnitude of the control measures required in the Philadelphia nonattainment area as well as elsewhere in the Commonwealth.

Sources of emission reductions affecting regional attainment can be thought of as coming from three increasingly larger areas:

- The Pennsylvania portion of the nonattainment area
- The state's portion of the modeling domain (shown in Figure 9.2)
- The rest of the Commonwealth.

It is not expected that emission controls just in the Commonwealth's portion of the Philadelphia nonattainment area (the counties of Bucks, Chester, Delaware, Montgomery and Philadelphia) will be sufficient to attain air quality standards in the Philadelphia nonattainment area. Thus, controls within the modeling domain but outside the nonattainment area will probably be necessary. Reductions will probably also be required beyond the modeling domain if the incoming air is to be clean enough to allow the urban area to meet standards. Finally, further reductions may be necessary in each of these three areas if neighboring domains are to meet air quality standards.

The ozone concentrations predicted by the regional model (ROM) with the 1990 interim emissions inventory for the July 1988 meteorological conditions show a significant portion of Pennsylvania exceeding the health-based standard for ozone. In addition, a larger portion of the region has levels close to this standard and arguably, at these levels impacts the health of an even greater number of persons.

In the 2005 future year ozone prediction (see figure 9.4, shown previously), a substantial portion of the region continues to exceed the health standard despite a full implementation of the CAAA mandated emission controls, such as RACT for stationary sources of VOCs/NOx and enhanced inspection/maintenance programs. While these measures are effective in reducing emissions, growth in vehicle traffic and other sources make final attainment of the ambient ozone standard challenging. Much of the high ozone levels are concentrated in the urban areas along the eastern seaboard where the Northeast's population is most concentrated. The obvious conclusion is that even as measured by the current ozone health-based standard, the full force of CAAA-mandated controls alone, while effective, will not be able to provide for attainment in the Philadelphia region and in downwind New York areas. Additional strategies will be necessary.

The modeling supports a conclusion that both NOx and VOC reductions are needed beyond the Act's requirements, and that a regionally applied program of NOx reductions are needed to protect public health. OTC studies, as well as those of the National Academy of Sciences, suggest that VOC controls should be very effective in controlling the ozone peaks in the urban cores of the region, while NOx controls should be very effective at controlling the areawide extent of high ozone levels by cutting down on regional transport.

Current emission inventories show substantial contributions from both stationary and mobile sources. Therefore, any strategy for attainment must be balanced and include strategies for both.

10.1 PENDING REGIONAL MEASURES

10.1.1 STATIONARY SOURCES

As part of a balanced approach, the states of the OTC are taking cooperative action to control stationary sources. Pennsylvania and the other OTC states have implemented RACT for both VOC and NOx. Furthermore, the Commonwealth is committed to additional NOx reductions from major stationary sources as indicated by the following MOU recently accepted by the OTC states.

MEMORANDUM OF UNDERSTANDING
AMONG THE STATES OF THE OZONE TRANSPORT COMMISSION
ON DEVELOPMENT OF A REGIONAL STRATEGY CONCERNING THE CONTROL OF STATIONARY SOURCE NITROGEN OXIDE EMISSIONS

WHEREAS, the States of the Ozone Transport Commission (OTC) face a pervasive problem in their efforts to attain the National Ambient Air Quality Standard (NAAQS) for ozone; and

WHEREAS, a 1991 National Academy of Sciences study on ground-level ozone indicates that a combination of reductions in emissions of volatile organic compounds (VOCs) and nitrogen oxides (NOx) will be necessary to bring the entire Ozone Transport Region (OTR) into attainment by the statutory attainment dates; and

WHEREAS, modeling and other studies confirm that NOx emission reductions are effective in reducing ozone formation and help to reduce ozone transport; and

WHEREAS, the States of the OTC are requiring major stationary sources of NOx to implement reasonably available control technology (RACT); and

WHEREAS, by November 15, 1994, the States must submit attainment demonstrations to EPA as State Implementation Plan (SIP) revisions; and

WHEREAS, the implementation of RACT for the control of NOx emissions will not be sufficient to enable all States in the OTR to reach attainment; and

WHEREAS, the undersigned States seek to develop an effective regional program to reduce NOx emissions, which would be implemented in conjunction with other measures to control ozone precursors (including state-specific measures, regional measures and Federal measures required under the Clean Air Act); and

WHEREAS, these measures together may enable EPA to approve the States' SIPs and refrain from imposing sanctions that could restrict economic growth throughout the OTR; and

WHEREAS, information that the States have collected in their emissions inventories shows that large boilers and other large indirect heat exchangers are the source of a substantial portion of the NOx emissions in the States, and will continue to be so after they implement RACT;

WHEREAS, the States intend to complete a reevaluation of stationary source controls for 2003 and beyond in 1997, based on results of EPA-approved models and other relevant technical data;

THEREFORE, the undersigned member States hereby agree to propose regulations and/or legislation for the control of NOx emission from boilers and other indirect heat exchangers with a maximum gross heat input rate of at least 250 million BTU per hour; and

FURTHERMORE, that the States agree to propose regulations that reflect the difference in conditions in (i) the OTR's "Northern Zone" consisting of the northern portion of the OTR; (ii) the OTR's "Inner Zone" consisting of the central eastern portion of the OTR; and (iii) the OTR's "Outer Zone" consisting of the remainder of the OTR; and

FURTHERMORE, that to establish a credible emissions budget, the States agree to propose regulations that require enforceable specific reductions in NOx emissions from the actual 1990 emissions set forth in each State's 1990 inventory submitted to EPA in compliance with § 182(a) (1) of the Clean Air Act or in a similar emissions inventory prepared for each attainment area (provided that for exceptional circumstances that a more representative base year may be applied to individual sources in a manner acceptable to EPA) subject to public notice; and

FURTHERMORE, that the States agree to develop a budget in a manner acceptable to EPA based on the principles above no later than March 1, 1995; and

FURTHERMORE, if such a budget is not developed by March 1, 1995, that the 1990 interim inventory used by EPA in its Regional Oxidant Model simulations for the 1994 OTC Fall Meeting will be used for the budget; and

FURTHERMORE, that the States agree to propose regulations that require subject sources in the Inner Zone to reduce their rate of NOx emissions by 65 percent from base year levels by May 1, 1999, or to emit NOx at a rate no greater than 0.2 pounds per million BTU; and

FURTHERMORE, that the States agree to propose regulations that require subject sources in the Outer Zone to reduce their rate of NOx emissions by 55 percent from base year levels by May 1, 1999, or to emit NOx at a rate no greater than 0.2 pounds per million BTU; and

FURTHERMORE, that the States agree to propose regulations that require sources in the Inner Zone and the Outer Zone to reduce their rate of NOx emissions by 75 percent from base year levels by May 1, 2003, or to emit NOx at a rate no greater than 0.15 pounds per million BTU; and

FURTHERMORE, that the States agree to propose regulations that require subject sources in the Northern Zone to reduce their rate of NOx emissions by 55 percent from base year levels by May 1, 2003, or to emit NOx at a rate no greater than 0.2 pounds per million BTU; and

FURTHERMORE, that the States agree to develop a regionwide trading mechanism in consultation with EPA; and

FURTHERMORE, that in lieu of proposing the regulations described above, a State may propose regulations that achieve an equivalent reduction in stationary source NOx emissions in an equitable manner; and

FURTHERMORE, that the regulations for May 1, 2003 described above may be modified if (i) additional modeling and other scientific analysis shows that the regulations as modified, together with regulations governing VOC emissions, will achieve attainment of the ozone

NAAQS across the OTR, and (ii) this Memorandum of Understanding is modified to reflect those modeling results and other analysis no later than December 31, 1998; and

FURTHERMORE, that the States agree to propose regulations that are otherwise consistent with the attached recommendations of the OTC's Stationary/Area Source Committee; and

FURTHERMORE, that the undersigned States agree to request that the EPA Administrator determine whether the SIPs of States outside the OTR contain adequate provisions to prohibit the emission of air pollutants in amounts that will contribute significantly to nonattainment of a National Ambient Air Quality Standard (NAAQS) within the OTR, as required under 42 U.S.C. Section 110(a)(2)(D).

10.1.2 MOBILE SOURCES

The Commonwealth may be required to adopt a Low Emission Vehicle program or a similar program in order to ensure attainment and maintenance of the ozone standard in the Northeast.

Section 184(c) of the CAAA specifies the procedure that the OTC must use in developing recommendations for additional control measures to be applied within all or a part of the region if the OTC determines that such measures are necessary to bring any area in the Ozone Transport Region (OTR) into attainment for ozone by the applicable dates in the law. That section also contains the process by which EPA must respond to this recommendation. In brief, should EPA adopt an OTC recommendation submitted to it under a Section 184 petition, EPA will require states to amend their State Implementation Plan incorporating regulations and/or procedures which implement the recommendation.

In July 1991, the OTC adopted a Memorandum of Understanding in which the member jurisdictions agreed to evaluate the feasibility, air quality benefits and associated costs of adopting California's Low Emission Vehicle Program in the Northeast.

In Pennsylvania, Act 166 (HB 2751 of 1992) established the 13-member Pennsylvania Low Emission Vehicle Commission which completed a study for the Commonwealth. The Commission's final report was submitted to the Governor on August 13, 1993. The Commission also adopted resolution which stated that the available data regarding emissions reductions and the cost-effectiveness of such reductions attributable to LEV are inconclusive and recommended that Commonwealth agencies not propose or adopt a LEV program before January 1, 1995. The Commission further recommended that prior to proposing such a program, the legislature be provided with a report regarding the Commonwealth's attainment status for ozone.

In August 1993, Maine, Maryland and Massachusetts petitioned the Ozone Transport Commission to adopt a recommendation calling for the application of the California Low Emission Vehicle (LEV) program throughout the region. Under Section 7.4 of the Air Pollution Control Act, the Commonwealth is required to provide an opportunity for public review of recommendations for additional control measures prior to final OTC action. A public hearing on a draft petition was held December 14, 1993 with a comment period closing January 7, 1994.

The OTC is also required to provide for public participation; public workshops were held during the fall of 1993 and OTC public hearings were held December 16-17, 1993 with a comment period closing January 7, 1994.

The OTC voted on February 1, 1994 to adopt that recommendation, determining that an LEV program was "necessary to bring the Ozone Transport Region into attainment by the dates provided in the Clean Air Act" and subsequently submitted such a petition to EPA.

The petition provided that manufacturers would be required to sell vehicles meeting certain advanced emission standards established by the California Air Resources Board under a federal pre-emption waiver. The petition recommended that:

- The OTC LEV program be applicable to all 1999 and subsequent model year passenger cars and light duty trucks;
- A series of yearly fleet average emission standards be established within which manufacturers could choose any combination of vehicles to meet the sales mandate;
- Participating states would have the option to mandate that Zero Emission Vehicles be sold in that state;
- California reformulated gasoline not be required;
- EPA evaluate alternative proposals in terms of enforceability, timeliness and quantity of emission reductions, including the proposal submitted by the automobile manufacturers.

The automakers had circulated an alternative proposal for a "49-state car," that is, a low emission vehicle which would be sold in all states except California (which has its own program), rather than just the Northeast. That program continues to be under consideration.

The petition included the following reasons for recommending a LEV program in the Northeast:

- "Regional ozone modeling to date has shown the need for emission reductions beyond those which will be realized through the strategies specifically included in the CAAA"
- "motor vehicles, in the aggregate, are the single largest source of ozone precursors within the OTR and introduction of Low Emission and Zero Emission Vehicles are essential"
- "Based on the technical analysis done by the States of the OTC to date LEVs provide substantial and cost effective emission reductions"

The OTC also submitted a technical support document which described the basis on which the OTC concluded that an LEV program was necessary for regional attainment.

EPA is required to conclude a rulemaking on the petition by November 10, 1994.

EPA published a notice of availability of the OTC petition on March 18, 1994 and a notice of public hearing on April 8, 1994. A public hearing was held on May 2, 1994. EPA published a notice of proposed rulemaking on April 26, 1994 in which it set forth the issues EPA is considering in deciding whether to approve the OTC petition. On June 2, 1994, EPA published a notice of round-table meetings which were held on June 8, June 23 and July 13, 1994. On July 11, the comment period was extended to July 20, 1994.

EPA published a supplemental notice of proposed rulemaking on September 22, 1994, which proposed that reduction of new motor vehicle emissions through an OTC LEV or LEV-equivalent program is necessary to mitigate the effects of pollution transport and to bring nonattainment areas in the OTR into attainment and to avoid interference with maintenance of air standards. That notice also stated that EPA believes an alternative federal low emission vehicle program can be developed that would achieve reductions equivalent to or greater than the OTC LEV program and pledged to work with stakeholders to develop such a program. A federal advisory committee was established to accomplish this task.

As of the date of this SIP submission, EPA has not concluded its rulemaking.

Whether the final result of the rulemaking is OTC LEV or a 49-state car, the Department believes that advanced control of emissions from new vehicles is an especially effective strategy because it reduces both VOC and NOx and accomplishes both NOx reductions regionwide and VOC reduction in the urban cores. Advanced controls for new vehicles reduces the largest part of emissions from highway vehicles. Finally, given the need for regionwide strategies, an advanced new car program should be OTR-wide at a minimum because of the movement and sales patterns of motor vehicles throughout the Northeast states.

11.0 REFERENCES AND ENDNOTES

[1] U.S. Environmental Protection Agency. 1991. Non-road Engine and Vehicle Emission Study-Report. EPA 21A-2001, Office of Air and Radiation, Washington, D.C., 1991. pp. 1 to 118.

[2] Memorandum from Phil Lorang, Director, Emission Planning and Strategies Division, U.S. Environmental Protection Agency, to EPA Regional Office Air Directors, Status of Nonroad Inventory Work. April 27, 1992. pp. 1 to 5.

[3] Procedures for Emission Inventory Preparation, Volume IV; Mobile Sources (EPA-450/ 4-81-06d (Revised)), January 1992 and The Users Guide to Mobile 5a Emission Factor Model (EPA-AA-TEB-91,01), April 1993.

[4] 42 U.S.C.A. §7511a(b)(1)

[5] U.S.E.P.A., Procedures for Preparing Emissions Projections, July, 1991.

[6] U.S. Dept. of Commerce, Bureau of Economic Analysis, BEA Regional Projections to 2040, June, 1990.

[7] 40 C.F.R. Part 52; 57 Federal Register 13509 (1992)

[8] Perchloroethylene emissions were removed from the 1990 Baseline Inventory because of the EPA determination that it is a "negligibly reactive volatile organic compound" see EPA memo; Perchloroethylene Emissions from Degreasing, from G.T. Helms to EPA Regional Air Branch Chiefs, May 13, 1993.

[9] 42 U.S.C.A. §7511a(b)(1)(B) requires all states to eliminate the effect of both the January 1, 1990, FMVCP program and the June 11, 1990, Federal Reid Vapor Pressure (RVP) regulations from their 1990 Adjusted Baseline Inventory. Since both these measures pre-date the 1990 Clean Air Act Amendments states are not permitted to take credit for emission reductions from these sources

[10] RACT "fix-ups", like the FMVCP and RVP, may not be considered as part of the required 15% reduction under the Act since they were required prior to 1990 - even if they were not implemented before 1990. See 42 U.S.C.A. §7511a (b)(1)(D).

[11] Memorandum from Phil Lorang, Director, Emission Planning and Strategies Division, U.S. Environmental Protection Agency, to EPA Regional Office Air Directors, VOC Emissions Benefits for Nonroad Equipment with the Use of Federal Phase 1 Reformulated Gasoline, August 18, 1993.

[12] Section 182(d)(1)(B)

[13] 42 U.S.C.A. §7502(c)(9)

[14] EOSHI Ozone Research Center, Regulatory Ozone Modeling: Status, Directions and Research Needs, June, 1994

[15] EOSHI is joint project of UMDNJ - Robert Wood Johnson Medical School, and Rutgers, The State University of New Jersey; ORC has been established through funding by the New Jersey Department of Environmental Protection and Energy.

APPENDIX I. DEFINITIONS

AADT	Average Annual Daily Traffic
AWDT	Average Weekday Traffic
AFS	AIRS Facility Subsystem
AIRS	Aerometric Information Retrieval System
ALAPCO	Association of Local Air Pollution Control Officials
AMS	AIRS Area and Mobile Subsystem
APO	Average Passenger Occupancy
BAQC	PA DER Bureau of Air Quality Control
BEA	U.S. Dept. of Commerce, Bureau of Economic Analysis
BPR	Bureau of Public Roads
BTSP	PA DOT Bureau of Transportation System Performance
CAAA	Clean Air Act Amendments of 1990
CAP	Compliance Advisory Panel
CFR	Code of Federal Regulations
CHIEF	Clearing House for Inventory/ Emission Factors
CMSA	Consolidated Metropolitan Statistical Area
CTG	Control Techniques Guidance
DER	PA Department of Environmental Resources
DVMT	Daily Vehicle Miles Traveled
DVRPC	Delaware Valley Regional Planning Commission
E-GAS	Economic Growth Analysis System
EEA	Energy and Environmental Analysis Inc.
EIB	U.S. EPA Emission Inventory Branch
EPA	U.S. Environmental Protection Agency
ETR	Employer Trip Reduction
FIPS	Federal Information Procedures System
FMVCP	Federal Motor Vehicle Control Program
HPMS	Highway Performance Monitoring System
LTO	Landing Take-off Operations
MACT	Maximum Available Control Technology
MSS	Major Stationary Sources
NAAQS	National Ambient Air Quality Standards
NEDS	National Emissions Data System
OAM	Organization, Administration and Management
OAQPS	Office of Air Quality Planning and Standards
PC-BEIS	Biogenic Emissions Inventory System
PEDS	Pennsylvania Emissions Data System
PENNDOT	Pennsylvania Department of Transportation
Perc.	Perchloroethylene
PPAQ	Post Processor for Air Quality
RACT	Reasonably Available Control Technology

RMS	Roadway Management System
RVP	Reid Vapor Pressure
SIC	Standard Industrial Classification
SIP	State Implementation Plan
STAPPA	State and Territorial Air Pollution Program Administrators
TCM	Transportation Control Measure
TDM	Traffic Demand Model
TPD	Tons Per Day
TPSD	Tons Per Summer Day
TRI	Toxic Release Inventory
TTN	Technology Transfer Network
UAM	Urban Airshed Model
USR	Urban, Small-urban and Rural
VHT	Vehicle Hours of Travel
VMT	Vehicle Miles Traveled
VOC	Volatile Organic Compound